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REMOTENESS-COMPENSATION METHODOLOGY FOR BENEFIT/COST ESTABLISHM--ETC(U)
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REMOTENESS–COMPENSATION METHODOLOGY FOR BENEFIT/COST ESTABLISHMENT AND DISCONTINUANCE CRITERIA

JANUARY 1977

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Office of Aviation System Plans
Washington, D.C. 20591

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-ASP-76-7		

4. Title and Subtitle
Remoteness-Compensation Methodology for Benefit/Cost Establishment and Discontinuance Criteria

5. Report Date
January 1977

6. Performing Organization Code

7. Author(s)
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8. Performing Organization Report No.

9. Performing Organization Name and Address
U. S. Department of Transportation
Federal Aviation Administration
Office of Aviation System Plans
Washington, D. C. 20591

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

12. Sponsoring Agency Name and Address

13. Type of Report and Period Covered
Final Report

14. Sponsoring Agency Code

15. Supplementary Notes
11 Jan 77 12 57p.

16. Abstract

This report develops a procedure for adjusting the benefit/cost (B/C) ratios by which proposals for FAA terminal facilities in remote locations are evaluated. The procedure is applicable to the types of installations for which B/C analyses, based on nationwide average data, are incorporated in Airway Planning Standard Number One (FAA Order 7031.2B). Without such an adjustment, proposals for facilities in Alaska and other such locations could not realistically be compared with those for facilities in the contiguous 48 states (CONUS).

The compensatory methodology first adjusts construction and installation costs according to a geographically differentiated index. Staff housing cost is subtracted. Exceptional site-preparation and other cost elements are not discarded, but their cost is made equivalent to the cost of doing the same work at a corresponding CONUS site.

Next, for facilities to serve remote communities shown to be exceptionally reliant on air transportation, the ascribed benefits are adjusted upward. This benefit enhancement is proportional to the communities' aviation-dependency as determined by the model contained in this report, but it is not permitted to more than double intrinsic benefits. The benefit-enhancement premium is earned by a relatively few sites where large numbers of citizens are without alternative transportation links to the outside world for extended periods.

17. Key Words	18. Distribution Statement
Remote Facilities, Alaskan Aviation, Benefit/Cost Ratio (B/C Ratio), Construction Cost, Aviation Dependency	Document is available to the public through the Office of Aviation System Plans of the Federal Aviation Administration

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	44	none

Form DOT F 1700.7 (8-72) *Reproduction of completed page authorized*

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DISTRIBUTION: W-2; RNC-2 (minus AF/AS/AT/FS/PL); RAF/AS/AT/FS/PL-3; FAS-1; FAF-2/3; FAT-1/2/3/5/6 (minimum)

EXECUTIVE SUMMARY

Benefit/cost (B/C) methodologies designed for the National Airspace System as a whole may not accurately reflect the economic viability of facilities at remote locations. This report develops a process for adjusting both the costs and the benefits of terminal air navigation facilities and air traffic control services for which Airway Planning Standard Number One (APS-1) contains B/C-based establishment and discontinuance criteria. To be eligible for this remoteness-compensation, such a facility must:

(a) be proposed for a location having construction costs 1.5 times as great as those in the Washington, D.C., area (report contains index); OR

(b) require construction by the Government of staff housing; OR

(c) serve a community not accessible year-round by at least one mechanized surface transportation mode.

The cost-adjustment procedure operates on the regional cost elements entered on FAA Form 2500-40 (9-76), in accordance with the "F&E Cost Estimating Procedures and Summaries Handbook" (Order 6011.4) as a part of every facility proposal. (This procedure is applicable only to establishment criteria.) The benefit-enhancement process augments the benefits ascribed to a facility if it serves a community shown to be exceptionally reliant upon air transportation. This adjustment is proportional to the community's aviation dependency as determined by the model contained in this report. (This process is applicable both to establishment and to discontinuance criteria.)

The cost-adjustment procedure has the greatest impact in most cases. This procedure is based on historical cost data. It has been conservatively designed to adjust higher remote-site costs to be almost equivalent to what they would be in the contiguous 48 states (CONUS).

The benefit-enhancement premium is earned by a very few sites where relatively large numbers of citizens are without alternative transportation links to the outside world for extended periods.

Remoteness-compensation methodology will be applied by the Office of Aviation System Plans in the Federal Aviation Administration (FAA) Washington headquarters using data readily available to and submitted by FAA regions. However, the compensatory arithmetic is not complex, and regions may want to try it out on facility proposals still under consideration at that level. Therefore, detailed, step-by-step instructions and tables of preprocessed input data are included in this report to make the calculations as simple as those for an individual income tax return.

I. INTRODUCTION

The Federal Aviation Administration (FAA) consistently tries to maximize the levels of safety and convenience that its budget dollars buy for aviation users. In order to place new facilities and services where they are most needed, the FAA is continuously refining Airway Planning Standards and now uses benefit/cost (B/C) analysis to improve the basis for making investment decisions for terminal air navigation facilities and air traffic control services included in Airway Planning Standard Number One (APS-1). Costs of establishing, operating, and maintaining a facility (or service) are compared with the value of the benefits it provides. Benefits are measured by the cost of accidents, delays, and other disruptions that are averted and by savings in operating/maintenance costs when newer, more efficient systems are substituted for old ones. This report describes the development and application of procedures for adjusting projected costs and calculating benefit enhancement factors for terminal air navigation facilities proposed for remote areas.

The Problem

A recurrent difficulty in applying investment criteria based on the benefit/cost technique has been the failure of most proposed remote frontier facilities to qualify, usually due to their exceptionally high establishment costs. The severity of these cost differences can be seen at a glance from the graph on page 8.

Evaluation criteria based on nationwide average data cannot reasonably be applied to locations having such exorbitant costs. When it is attempted, say for an Alaskan site, the higher price of an installation there is accurately predicted by experienced FAA estimators, but the impact of higher Alaskan prices (associated with delays, accidents, etc.) cannot readily be figured into the complex benefit calculations, which differ for different facility types.

To enable remote facility proposals to compete realistically, an allowance for higher prices must be made--either by making establishment costs comparable to those elsewhere or by reflecting the higher prices in benefit computations. The

cost-adjustment approach was selected for reasons detailed in Part II, "Basic Considerations."

There was a second shortcoming in the indiscriminate application of B/C analysis to remote facilities. Benefit calculations did not include any premium related to the greater reliance on aviation of communities not accessible by surface transportation. Yet these conditions are typical in many parts of Alaska served neither by highways nor, most of the year, by water transport.

This aviation dependency, although it defies valuation in absolute dollar terms, is a factor long recognized by FAA executives as worthy of consideration in planning for remote areas. It is in effect another benefit, distinct from those quantified in benefit formulae applied to the National Airspace System as a whole. Approximating the degree of this aviation dependency is an operation separate from that performed to allow for the higher costs in remote locations. Benefit-enhancement methodology contains no cost elements and is in no way redundant with cost-adjustment procedures.

"Remoteness" Defined

For purposes of this report and application of the procedures it develops, a "remote" facility is one which would:

- require construction by the FAA of housing for personnel needed to staff or maintain it, or

- be located where construction costs are at least 1.5 times as great as those in Washington, D.C., as indicated in the composite construction cost index contained in this report, or

- serve a community not accessible, from a larger city or intermodal transfer point, by at least one alternative mechanized mode of transportation year-round.

The selection of these factors and the reasons for limiting the application to terminal facilities are discussed in Part II, "Basic Considerations." Although there are more or less remote sites in many states, most are in Alaska, and it is for the Alaskan Region that a systematic approach to evaluating proposals is most needed. Therefore, this report

treats the remoteness problem in the Alaskan context, but the resulting procedures and techniques are applicable to remote facilities elsewhere.

Background

The concept of making special allowances for developing the American hinterland is almost as old as the country itself. For aviation facilities, the trend toward progressively more rational investment criteria has provoked increasing concern that the legitimate needs of frontier areas might be slighted. The following is a brief chronology of efforts to avert this:

- In late 1971, then Deputy Administrator Smith directed that establishment criteria for instrument landing systems (ILS) be adjusted to enable remote sites to qualify more easily. The result was a table of multiplying factors to artificially increase the count of annual instrument approaches (AIA), this being the establishment criterion for ILS at the time. The worse the weather and the greater the alternate-mode travel time, the higher the multiplier. By this device, an airport inaccessible under visual flight rules (VFR) more than 90 days per year and taking longer than 48 hours to reach by an alternative mode of travel could qualify for an ILS installation with as few as 35 AIA's instead of the 700 otherwise required. Although the basic establishment standard was later revised using B/C analysis, the table of multipliers remained a part of ILS establishment criteria. (The procedures in this report supersede that adjustment provision.)

- In 1974, then Administrator Butterfield created a special task force to consider Alaskan aviation needs. Major Issue #7 of the Task Force Report was "whether the FAA resource allocation process meets aviation requirements in Alaska." The present report and methodology are an outgrowth of the Task Force inquiry.

- In early 1975, the Alaskan Region, commenting on a draft action plan for implementing the Task Force recommendations, suggested that investment goal scores for Alaskan proposals be weighted to reflect the aviation-dependency of the communities to be served. Weighting coefficients were to be passengers-served-per-resident and cargo-handled-per resident. This technique was not adopted,

but the suggested approach contributed significantly to the development of the methodology described in Part IV of this report.

An October 1975 study by FAA's Systems Research and Development Service of Alaskan en route navigation facilities (addressing Task Force Report Major Issue #3) cites an Aviation Dependency Model created by Alaska's Department of Public Works for ranking airport improvement priorities. Communities are graded on a combination of population, alternate-mode availability; distance from trunk airport, primary industry, class of post office, and other such variables reflecting reliance on aviation. Other factors important to the state but less relevant to FAA planning included school attendance and whether or not the town is incorporated.

It is important to note that Alaska was not altogether deprived of new terminal air navigation facilities while these efforts were being made. However, the new installations that were programmed usually represented exceptions to prevailing establishment criteria, since Alaskan proposals, considered on the basis of projected actual cost, rarely met B/C-based planning standards. These exceptions constituted reversions to the more subjective evaluative process that economic analysis was intended to supersede. While this was necessary to provide a modicum of aviation safety in remote areas, it still did not amount to systematic, valid comparison of the desirability of remote facilities with those elsewhere.

The compensatory procedures described in this report are applicable only to Phase II (Washington office B/C calculations) and not to Phase I screening, which is based on system-average costs and commensurate, empirically-derived benefit allowances. Phase I criteria have not discriminated against remote areas.

Benefit enhancement is applicable to discontinuance criteria B/C ratios. Cost adjustment, however, is not, because construction is rarely a cost of discontinuance. Dismantling/demolition costs are a relatively insignificant element of discontinuance criteria, and system-average values are used.

II. BASIC CONSIDERATIONS

Remoteness-compensation methodology has been developed within the context of the fundamental purpose of Airway Planning Standards--the provision of facilities on the basis of demonstrated need. To serve this objective and at the same time devise a readily usable technique, the following assumptions were established as the practical limits within which the methodology was devised:

A. Preservation of Fundamental Planning Standards

Economic analyses employing benefit/cost methodology already have been performed to refine planning standards for Category I and II instrument landing systems (ILS), airport surveillance radar (ASR), airport surface detection equipment (ASDE), airport traffic control towers (ATCT), and visual approach slope indicators (VASI)[1]. These analyses reflect the most thorough available examination and assessment of the benefits associated with the respective facilities. This and other practical considerations dictate that these fundamental methodologies not be altered for remote facilities and, moreover, that the aviation-dependency benefit not be a more important factor than the sum of safety/convenience/other benefits determined by standard methodology. Thus, the benefit enhancement factor should not be allowed to more than double the unadjusted benefits.

B. Universality of Application

A corollary consideration is the desirability of having a single mechanism that can be applied to any type of terminal facility proposal. This purpose too is served by having an adjustment methodology which transforms input data and/or

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1. See: Report No. ASP-75-1, "Establishment Criteria for Category I Instrument Landing System (ILS)," December 1975; Report No. ASP-75-2, "Establishment Criteria for Airport Surveillance Radar (ASR/ATCRBS/BDS)," December 1975; Report No. ASP-75-3, "Establishment Criteria for ASDE-3 (Airport Surface Detection Equipment)," December 1975; Report No. ASP-75-4, "Establishment Criteria for Airport Traffic Control Towers (ATCT)," October 1975; Report No. ASP-76-1, "Establishment Criteria for Category II Instrument Landing Systems (ILS)," July 1976; and Report No. ASP-76-2, "Establishment Criteria for Visual Approach Slope Indicator System (VASI)," draft dated July 1976.

operates on the B/C ratio result of a previously established qualifying routine--rather than altering the routine itself.

C. Input Data Base

The methodology should require only readily available input data, obtainable from Washington statistical agencies or easily accessible by FAA regions. This implies a trade-off of the accuracy with which a cost-deflation or aviation-dependency model can replicate circumstances as they actually occur. This compromise must, however, be made, both to ensure that the budget validation process is not retarded and to avoid imposing a significant additional data collection burden on the regions.

D. Application Threshold

To safeguard the integrity of Airway Planning Standards, application of compensatory methodologies should be limited to exceptional circumstances--those in which costs are so severe (Figure 1, page 8) or aviation dependence is so pronounced that few, if any, sites in the contiguous 48 states will qualify.

E. Variations in Remoteness

Remote/high-cost areas differ widely as to the degree of their remoteness and the level of their costs; any compensatory calculations should preserve these distinctions among localities to enable valid comparisons.

F. Limitation to Terminal Facilities

The procedures outlined in this report are not designed to be applied to en route facilities, because the benefits derived from en route navigational aids (navaids) generally are benefits to the aviation system and are not readily assignable to any single community. Further, the benefit-enhancement factors resulting from the methodology given here do not represent absolute values, but are instead multipliers to benefit/cost ratios. Among the navigation facilities provided by the FAA, only terminal facilities covered by APS-1 have undergone the economic analysis necessary to evolve benefit/cost formulae. The cost-adjustment procedure described in the following section could be applied to any site-specific facility proposal, the projected cost of which is itemized on FAA Form 2500-40. However, the remoteness-adjusted cost

figures produced by this process are useful primarily for calculating adjusted B/C ratios; therefore, application is limited to those facilities for which APS-1 contains B/C criteria.

The previous considerations, then, constitute the framework within which the following remoteness-compensation techniques were developed.

III. COST-ADJUSTMENT METHODOLOGY

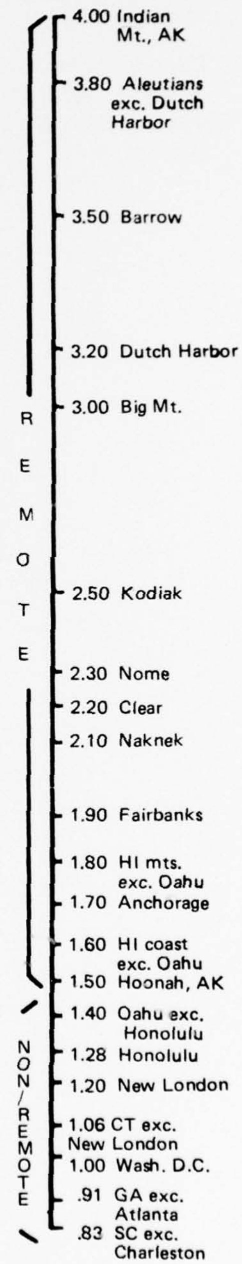
The figure at the right illustrates why candidly costed remote facility proposals did not fare well against establishment criteria created for the total National Aviation System. This index is based on construction costs in the Washington, D.C., area (D.C. = 1.00). The highest value for locations within the contiguous 48 states is 1.20 (New London); the lowest is 0.83 (South Carolina). Thus, most FAA facilities are programmed for an area throughout which the cost of construction varies no more than 20 percent from a median index value of 1.015 while some locations have costs almost four times as high.

The distortion of this comparative cost structure is compounded for places so sparsely settled that the FAA must construct staff living quarters. Inspection of Alaskan budget submissions indicates that these two factors--the higher overall level of construction/installation costs and the occasional requirement for FAA-built housing--account for most of the divergence from system-average establishment costs.

To arrive at a remote project artificial cost figure that will permit reasonable comparison with facility costs in the CONUS (contiguous 48 states), both of these factors are ameliorated. Other cost elements, such as equipment and other Washington costs, do not contribute significantly to the higher total cost incurred for remote facility establishment, so they are left alone.

Staff housing is so rarely required that its inclusion would inevitably skew project costs beyond the norms upon which standard B/C criteria are based. Therefore, any such cost elements are

Figure 1.
Composite cost index



deleted outright in calculating the remoteness-adjusted cost for a given project.

Treating the higher overall construction costs within the framework of the basic considerations previously outlined requires the use of a scale of relative construction costs. The composite construction cost index, cited in our "remoteness" definition and shown here (Figure 1) to illustrate the range of cost differences, is the basis for the adjustment methodology. The origin of this index is described in Appendix A.

Cost Adjustment Using the Composite Index

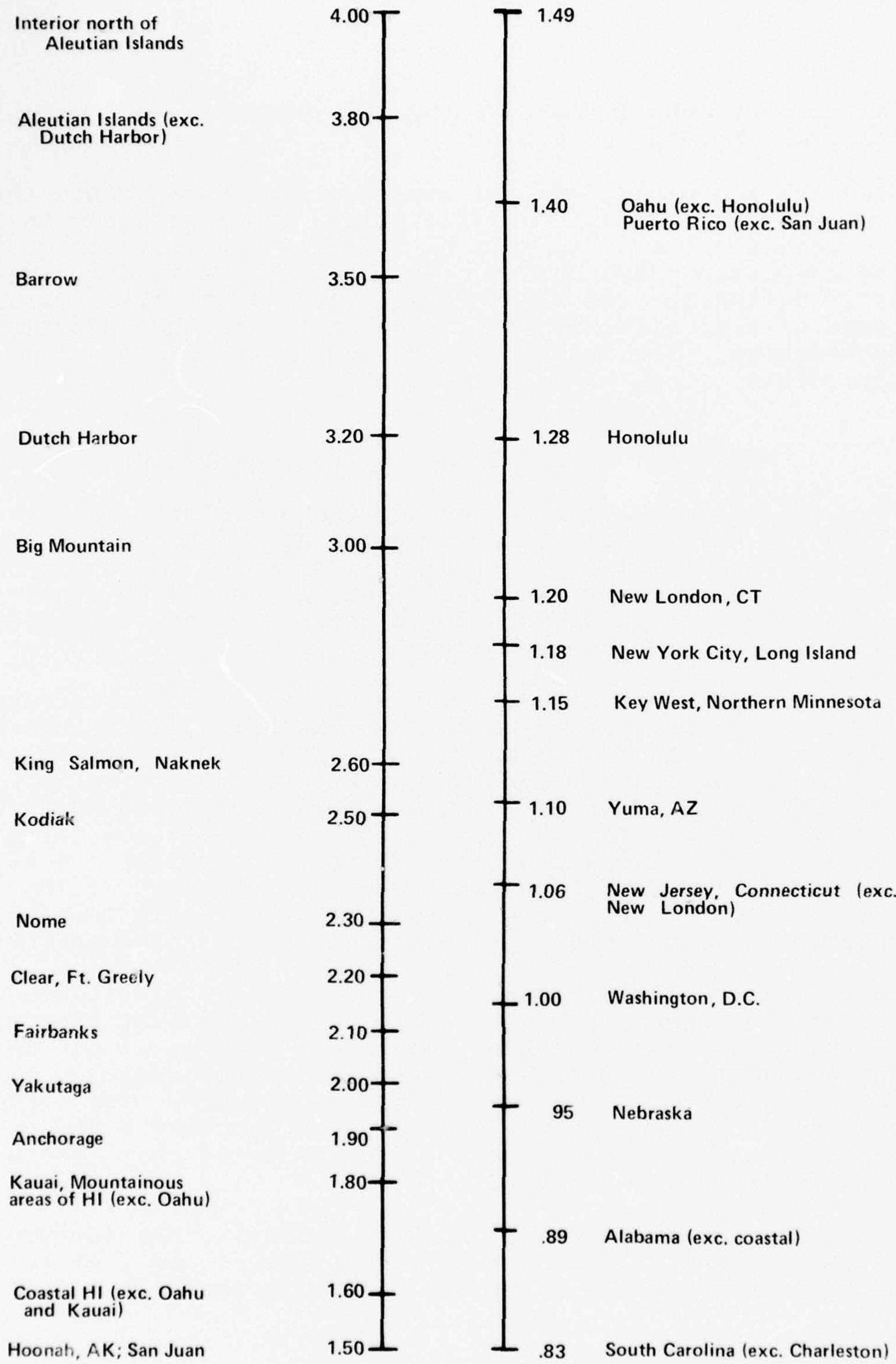
Figure 1 shows that the range of remote facility index values (1.50 - 4.00) is four times as great as the range for "non-remote" facilities (.83 - 1.49). Therefore, to make remote facility costs comparable with those in the CONUS requires some systematic reduction of the range of cost index values as well as their absolute level.

The compression required to make the range of remote cost index values equivalent to that for nonremote is a function of the threshold of remote values. The 1.50 figure selected is the lowest index value for any Alaskan point; it is higher than the Oahu index value (1.28) but lower than those for remoter Hawaiian islands (1.60) and mountainous areas (1.80). It includes the San Juan and Roosevelt Roads areas of Puerto Rico (1.50) but excludes the remainder of the Commonwealth (1.40). Thus, the 1.50 value satisfies the application threshold consideration (II.D.) noted earlier.

Consideration II.E. requires preservation of distinctions between locations. The cost differences are best preserved by the least compression of the remote portion of the index. But comparability with nonremote cost values suggests the remote range be no greater than the nonremote. The optimum compression, then, is that which makes the remote index range equal to the nonremote. The result of this compression is illustrated by Figure 2.

For every remote index value (R_i), an equivalent nonremote level (C_i) can be found graphically from Figure 2 or determined mathematically using the following formula:

Figure 2.--Composite Cost Index: Remote/non-remote equivalency (Corrected to FY78-79)



$$C_i = \frac{(R_i - R_{min}) \cdot (C_{max} - C_{min})}{R_{max} - R_{min}} + C_{min}$$

where C is the nonremote scale and R is the remote scale. (Thus, Nome, about one-third up the remote portion of the index at 2.30, has an equivalent cost index value of 1.04, about one-third of the way between those of the lowest and highest cost nonremote locations.)

Applying the ratio R_i/C_i to the construction cost for a remote facility yields a remoteness-adjusted construction cost that approximates the cost of constructing that facility in a corresponding nonremote location.

It is important to note that this index-derived procedure is applicable only to construction/installation costs--not to other project costs. The application of this adjustment procedure is described in the following section.

Table 1 lists all of the remote locations entered on the composite construction cost index with their index values (R_i), nonremote equivalents (C_i), and adjustment factors (R_i/C_i). Resort to general entries (e.g., "Aleutian Islands") only if more specific place names are not listed.

Application of the Construction Cost Adjustment Procedure

The four-step process described in this section produces an adjusted regional cost figure which may then be added to Washington office cost (never adjusted) to arrive at artificial project cost for use in B/C calculations. This process is shown schematically in Figure 3.

Because true costs will nonetheless be incurred, the following precautions must be taken against possible confusion of adjusted and actual amounts: (a) adjusted-cost values may never be shown on any FAA Form 2500-40; (b) artificial cost figures and B/C calculations and ratios based on adjusted costs must be identified as "remoteness-adjusted" or "artificial" wherever they appear; and (c) any matter dealing with adjusted cost must also contain the corresponding actual cost value immediately afterward in parentheses unless shown elsewhere in the same text paragraph, on the same page.

TABLE 1

Remoteness Cost Adjustment Factors

Remote Location	Composite Index	Non-Remote Equiv.	Adj. Factor (R/C)
Alaska			
Aleutian Islands	3.80	1.44	2.64
Anchorage	1.90	0.94	2.03
Aniak	2.80	1.17	2.39
Aurora	2.50	1.09	2.29
Barrow	3.50	1.36	2.58
Barter Island	3.60	1.38	2.60
Bear Creek	2.90	1.20	2.42
Beaver Creek	1.90	0.94	2.03
Bethel	2.80	1.17	2.39
Big Delta	2.20	1.01	2.17
Big Mountain	3.00	1.23	2.45
Black Rapids	2.30	1.04	2.21
Boswell Bay	3.00	1.23	2.45
Champion	2.80	1.17	2.39
Canyon Creek	2.50	1.09	2.29
Cape Lisburne	3.50	1.36	2.58
Cape Newenham	2.80	1.17	2.39
Cape Romanzof	2.80	1.17	2.39
Cathedral	1.90	0.94	2.03
Chiniak	2.50	1.09	2.29
Clear	2.20	1.01	2.17
Coast North of Aleutians	3.50	1.36	2.58
Craig	1.90	0.94	2.03
Delta Junction	2.40	1.07	2.25
Donnelly Dome	2.00	0.96	2.08
Duncan Canal	2.30	1.04	2.21
Dutch Harbor	3.20	1.28	2.50
Eilson AFB	2.10	0.99	2.12
Elmendorf AFB	1.90	0.94	2.03
Fairbanks	2.10	0.99	2.12

TABLE 1 (cont'd)

Remote Location	Composite Index	Non-Remote Equiv.	Factor (R/C)
Ft Greely Big Delta	2.20	1.01	2.17
Ft Wainwright Ladd	2.10	0.99	2.12
Ft Yukon	2.60	1.12	2.32
Galena	2.80	1.17	2.39
Gerstle River	2.10	0.99	2.12
Glenallen	2.20	1.01	2.17
Gold Creek	2.20	1.01	2.17
Granite Mt	3.00	1.23	2.45
Gulkana	2.40	1.07	2.25
Harding Lake	2.50	1.09	2.29
Hoonah	1.50	0.83	1.81
Homer	1.90	0.94	2.03
Indian Mt	4.00	1.49	2.68
Inland North of Aleutians	4.00	1.49	2.68
Juneau	1.80	0.91	1.98
Kalakleet	3.00	1.23	2.45
Kenai	2.10	0.99	2.12
Ketchikan	2.40	1.07	2.25
King Salmon	2.60	1.12	2.32
Knob Ridge	1.80	0.91	1.98
Kodiak	2.50	1.09	2.29
Kotzebue	2.40	1.07	2.25
McCallum	2.40	1.07	2.25
Middleton Island	2.00	0.96	2.08
Murphy Dome	2.00	0.96	2.08
Naknek	2.60	1.12	2.32
Neklasson Lake	2.20	1.01	2.17
Nome	2.30	1.04	2.21
North Hwy Area	2.30	1.04	2.21
Ocean Cape	2.00	0.96	2.08
Paxson	3.00	1.23	2.45
Pedro Dome	1.80	0.91	1.98
Pillar Mt	2.50	1.09	2.29
Sawmill	2.90	1.20	2.42
Skwentna	2.20	1.01	2.17

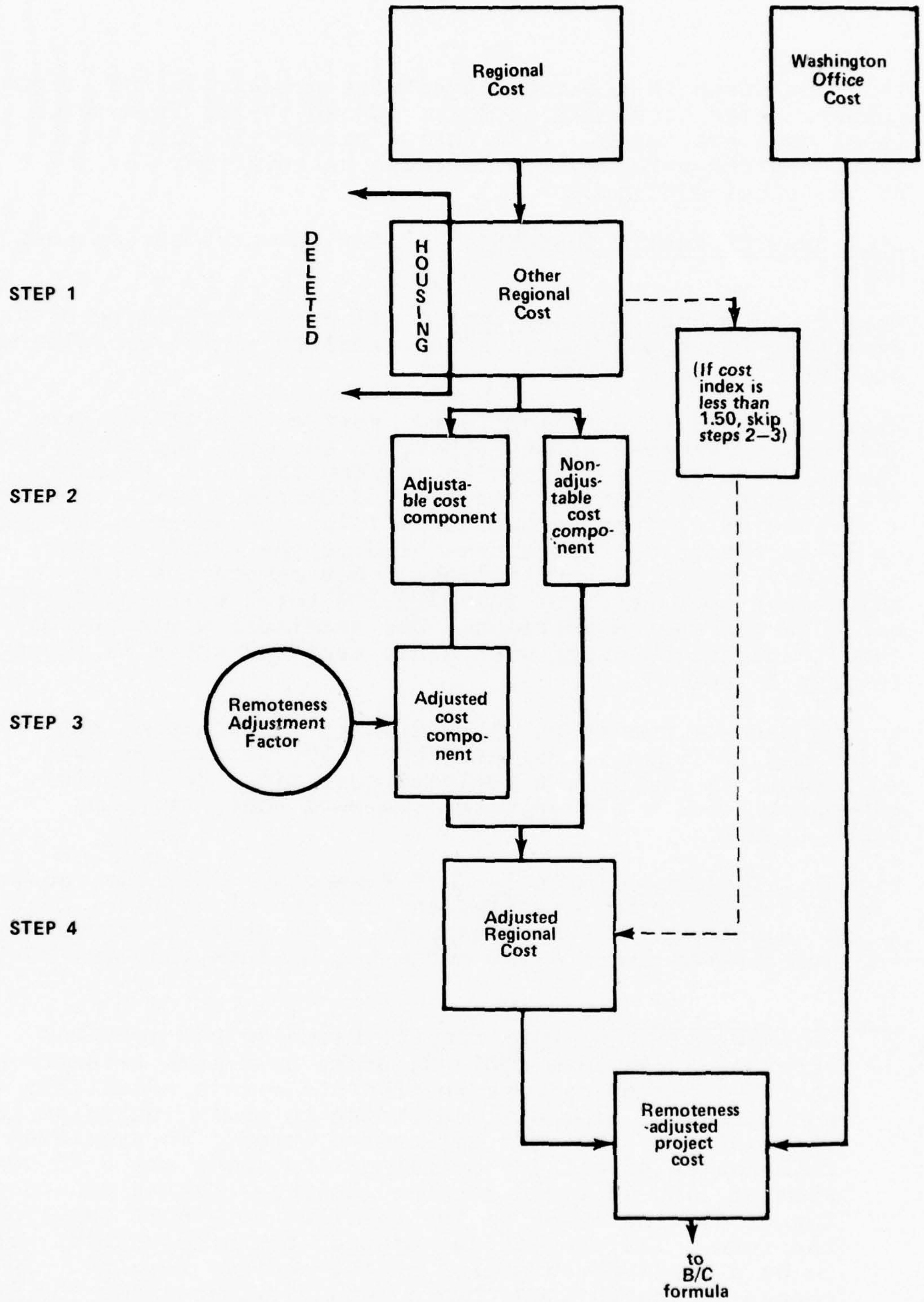
TABLE 1 (cont'd)

Remote Location	Composite Index	Non-Remote Equiv.	Factor (R/C)
Siktinak	2.50	1.09	2.29
Soldotna	1.80	0.91	1.98
Sparrevohn AFS	3.50	1.36	2.58
Tahneta Pass	2.50	1.09	2.29
Tatalina	3.50	1.36	2.58
Tin City	3.20	1.28	2.50
Tok Junction	2.40	1.07	2.25
Tolsona	2.30	1.04	2.21
Umnak	2.80	1.17	2.39
Wales	3.20	1.28	2.50
Whittier	2.10	0.99	2.12
Wildwood	2.00	0.96	2.08
Yakataga	2.00	0.96	2.08
Yakutat	2.00	0.96	2.08
Hawaii			
Non Oahu Generally#	1.60	0.86	1.87
Non Oahu Coastal#	1.60	0.86	1.87
Non Oahu Mtnous Areas#	1.80	0.91	1.98
Kauai#	1.80	0.91	1.98
American Samoa	2.20	1.01	2.17
Guam	1.80	0.91	1.98
Puerto Rico			
San Juan Vicinity	1.50	0.83	1.81

\# Oahu index is 1.28, so sites there do not qualify on a cost basis.

* Puerto Rican sites outside the San Juan vicinity have an index value of 1.40, so they do not qualify on a cost basis.

Figure 3.--Cost adjustment schematic



The four steps in the cost-adjustment process follow; line numbers refer to blocks on Form 2500-40 (9-76) from which input data are taken. (The entire process is then illustrated in the next section, showing calculations for the FY-78 Bethel ATCT proposal.)

STEP-BY-STEP COST ADJUSTMENT. (Refer to worksheet on next page.)

Step 1. Subtract Housing Cost. All costs associated with providing FAA-owned quarters for facility staff are deleted outright.

Where a composite building is to provide both living area and working/storage space, apportion the cost according to the relative area dedicated to residential use. EXAMPLE: The proposed St. Mary's, Alaska, ILS/DME/MALSR/REIL requires a 30-foot by 52-foot composite building, of which a 30-foot by 17-foot portion (about one-third of the total) is for dormitory, kitchen, and bathroom. For remoteness cost adjustment, one-third of the $319,200 total cost ($106,400) would be subtracted outright. The remainder would be subject to reduction along with other regional costs as shown in Step 2, below.

In the case of a site at which housing is required, but which has an index value less than 1.50, no further cost adjustment is made. The regional cost minus the housing component becomes the adjusted regional cost, skipping Steps 2 to 4.

Step 2. Isolate Adjustable Cost Elements. Only the construction and electronic installation portions of regional cost are to be adjusted. These correspond to the summary amounts (column B) from lines A-3-D and A-4-C of Form 2500-40, PG-1[2].

2. An early draft of this report, based on the previous version of FAA Form 2500-40, broke down each category of costs--engineering/construction/etc.--into adjustable and nonadjustable elements, according to their inclusion in the basis for the cost adjustment index. To preserve this degree of methodological purity using the 9-76 version of 2500-40 would require separate costing and totaling of 42 line items on the detailed worksheet pages of the form. The simplified approach taken here turns out to be a good approximation of the earlier results. Spot checks indicated less than a .005 variation from the B/C ratios calculated using the more complicated procedure.

COST ADJUSTMENT PROCEDURE

Regional Cost Subtotal (Line A-6 from FAA Form 2500-40 PG-1) . . . . ________

STEP 1: SUBTRACT HOUSING COST. . . . . -________

(Balance carries forward) ________

STEP 2: ISOLATE ADJUSTABLE COSTS:

Construction Cost Summary Amt. (Line A-3-D) . . . . ________

Electronic Installation Amt. (Line A-4-C) . . . . +________

(Sum = adjustable cost component) . . . . ________=-________

(Difference from Step 1 result; carry to Step 4) ________

STEP 3: REDUCE ADJUSTABLE COSTS (Use Table 1 of FAA-ASP-76-7):

(Enter proxy locations used if actual site not listed in Table 1, e.g., Naknek for Dillingham:

____)

(Adj. cost component) ________ ÷
(Adj. factor, from table) ___.____ = ________ +

STEP 4: SUM = ADJUSTED REGIONAL COST . . . . . . ________

The sum of construction (A-3-D) and electronic installation (A-4-C) is the adjustable cost. Subtract it from the result in Step 1. The adjustable portion is reduced in Step 3. Carry the nonadjustable remainder to Step 4.

Step 3. Adjust Eligible Costs. Select the appropriate adjustment factor from Table 1. If the candidate site is not named in the table, select the described region or closest location that best replicates the candidate site. If such a proxy entry is used, it should be identified in any presentations of adjustment calculations.

Divide the adjustable cost component (sum of A-3-D and A-4-C in Step 2) by the adjustment factor obtained from the third column of Table 1. The quotient is, logically, the adjusted cost component; it will be added to the nonadjustable component in Step 4.

Step 4. Reconstruct Regional Cost. Add the adjusted cost component from Step 3 to the nonadjustable cost component which was the remainder carried forward from Step 2. The sum is the adjusted regional cost; it is the artificial approximation of the regional cost of establishing a comparable facility at a corresponding nonremote location. Adding this figure in turn to the Washington office cost yields the remoteness-adjusted project cost. Depending on the B/C formula for the facility type in question, this adjusted project cost may be converted to an annual capital cost recovery figure to be added to operating expenses to arrive at the B/C denominator. The next section illustrates the evolution of the adjusted regional cost through the four steps shown above and its subsequent incorporation into the B/C methodology.

Illustration of the Cost Adjustment Methodology

The Alaskan Region has proposed establishing an airport traffic control tower (ATCT) at Bethel in the southwestern coastal area of the Alaskan mainland. Bethel is remote by at least two of the three standards set in Section I: (1) surface access is only by water during a few summer months; and (2) Bethel is at 2.80 on the composite cost index (corresponding to 1.17 on the nonremote scale). New housing was originally thought to be necessary for tower staff, but a revised proposal avoids this requirement.

Figure 4. -- Bethel ATCT Costs

RIS: BU 2500-4

F & E COST ESTIMATE SUMMARY FY 78	PROGRAM IDENTIFICATION						PROG. SUBM.		LN NO	ACTN	PROJECT		LOCATION			RUNWAY	
	BUD ITEM	PROJECT CODE: FACIL		WORK CODE	SUF	PROG. ORG.	FY	S			SBM.	REG	ID		SUF	NO.	LTR.
	1-2	3-6	7	8-10	11	12-13	14-15	16	17	18	19-20	21-22	23-25	26-27	28	29	32

CARD 1 ITEM EXPLANATION

SECTION A – REGIONAL COST

	ITEM	CARD COL.*	DETAIL* AMOUNT (A)	SUMMARY* AMOUNT (B)	TOTALS* (C)
1.	PLANT ENGINEERING				
	A. PLANT ENGINEERING (185 MAN DAYS + OTHER COSTS)	(33-36)	40.3		
	B. DRAFTING (65 MAN DAYS + OTHER COSTS)	(37-40)	7.2		
	C. TOTAL PLANT ENGINEERING ☐ NONE REQUIRED			47.5	
2.	ELECTRONIC ENGINEERING				
	A. ELECTRONIC ENGINEERING (70 MAN DAYS + OTHER COSTS)	(41-44)	14.1		
	B. DRAFTING (30 MAN DAYS + OTHER COSTS)	(45-48)	5.4		
	C. TOTAL ELECTRONIC ENGINEERING ☐ NONE REQUIRED			19.5	
3.	CONSTRUCTION				
	A. LABOR (MAN DAYS)	(49-52)			
	B. OTHER CONSTRUCTION COST (EXCEPT LAND ACQUISITIONS)	(53-56)			
	C. LAND ACQUISITION	(57-60)			
	D. TOTAL CONSTRUCTION ☐ NONE REQUIRED			683.5	
4.	ELECTRONIC INSTALLATION				
	A. LABOR (82 MAN DAYS)	(61-64)	21.5		
	B. OTHER INSTALLATION COSTS	(65-68)	2.8		
	C. TOTAL ELECTRONIC INSTALLATION ☐ NONE REQUIRED			24.3	
5.	FLIGHT INSPECTION (HOURS @ $ PER HOUR)	(69-72)			
6.	(SUM OF LINES 1C+2C+3D+4C+5) Subtotal Regional Cost				774.8

7. REGIONAL COST REVISED (IF YES ENTER "C") (73) ______ Note: FOR WASHINGTON USE ONLY
8. MASS CHANGE INDICATOR (INSERT "M") (74) ______

CARD 2 MANPOWER REQUIREMENTS BY CATEGORY – SUMMARY (DAYS)

9. (17) 7 (18) ______ 1. PLANT ENG. ______ (33-36) 2. ELECT ENG. ______ (37-40) 3. CONST ______ (41-44)
4. ELECT INSTL ______ (45-48) 5. FLT INSP ______ (49-51) 6. COST CTR ______ (52-56) 7. MASS CHG ______ (74)

CARD 3

LINE NO. (17) 8

SECTION B – WASHINGTON OFFICE COST

ACTION (18) ______

	ITEM	CARD COL.*	DETAIL* AMOUNT (A)	SUMMARY* AMOUNT (B)	TOTALS* (C)
10.	CONSTRUCTION MATERIEL				
	A. ATTACHED FAA FORM 4650-1	(33-37)	36.6		
	B. PROVISIONING – PARTS COMMON	(38-41)	1.0		
	C. PROVISIONING – OTHER THAN PARTS COMMON	(42-45)	0.8		
	D. FACTORY INSPECTION	(46-49)	1.1		
	E. FREIGHT	(50-53)	3.7		
	F. TOTAL CONSTRUCTION MATERIEL ☐ NONE REQUIRED			42.2	
11.	ELECTRONIC EQUIPMENT				
	A. ATTACHED FAA FORM 4650-1	(54-58)	42.2		
	B. PROVISIONING – PARTS COMMON	(59-62)	6.0		
	C. PROVISIONING – OTHER THAN PARTS COMMON	(63-66)	5.0		
	D. FACTORY INSPECTION	(67-70)	1.3		
	E. FREIGHT	(71-74)	1.3		
	F. TOTAL ELECTRONIC EQUIPMENT ☐ NONE REQUIRED			55.8	
12.	F & E TRAINING	(75-79)			
13.	(SUM OF LINES 10F+11F+12) SUBTOTAL WASHINGTON OFFICE COST				98.0
14.	(SUM OF LINES 6+13) UNIT TOTAL-TEMP COST/ENTER "T"	(80)			872.8

15. REMARKS

(Specimen approximated from FY-78 submission on previous edition of Form 2500-40.)

PROJECT TITLE Establish Tower Facilities	BUDGET ITEM	PAGE
LOCATION Bethel, Ak.	2C	80078

* LAST POSITION-TENTHS OF THOUSANDS

FAA Form 2500-40 PG 1 (9-76) SUPERSEDES FAA FORM 2500-40

Although the population of Bethel and its environs is only about 10,000, the community is heavily reliant on aviation. Steadily increasing activity qualified the Bethel airport for ATCT candidacy in the FY-78 Call for Estimates; the CY-75 activity count yielded a ratio-value sum of 1.32 (1.00 is qualifying; refer to APS-1). Using ATCT benefit/cost methodology (Report ASP-75-4), a Bethel tower is found to offer annual safety benefits valued at $185,492 and delay reduction and other benefits worth $47,967 for a total benefit value of $233,459. If this figure were divided by the system-average annual tower cost of $215,498, the Bethel proposition would be deemed economically viable with a B/C ratio of 1.08. But as the accompanying Form 2500-40 (Figure 4) shows, projected establishment cost for a Bethel tower is significantly higher than the system average. Annualized and added to system-average operating expense, it amounts to an annual tower cost of $257,931 (20 percent higher than the system-average $215,498). This results in a B/C ratio of 0.91.

The following sequence of calculations illustrates the methodology described in the preceding section. The remoteness-adjusted project cost approximates what the establishment cost of the Bethel tower would be if it were built at San Francisco. The cost-adjusted B/C ratio simulates that of a hypothetical airport there (or at some other index-related point) but with Bethel's levels of air carrier, air taxi, and general aviation operations. The benefit value is unchanged. Note that after the adjusted regional cost is computed, a second column is added to show true data for each succeeding operation.

Impact of Cost Adjustment

The effect of remoteness cost adjustment will, of course, vary depending both on the location and on the facility type. The location factor is taken into account in the use of a geographically differentiated index, but the cost mix for different facility types also can have a significant bearing on the impact possible with cost adjustment. In the case of airport traffic control towers, unadjustable Washington office cost is typically (in the CONUS) about one-fifth to one-fourth of the regional cost. As the proportion of unadjustable cost increases, as it does for ASR and ILS, the effect of the adjustment mechanism on the capital cost to be recovered diminishes.

Project Title: *Establish Tower*

Location: *Bethel, Alaska* FY- *78*

REMOTENESS-COMPENSATION WORKSHEET

....

Cost-Adjustment Procedure

Regional Cost Subtotal (Line A-6 from FAA Form 2500-40 PG-1) *774.8*

STEP 1: SUBTRACT HOUSING COST . . . . - *-0-*

(Balance carries forward) *774.8*

STEP 2: ISOLATE ADJUSTABLE COSTS:

Construction Cost Summary Amt. (Line A-3-D) *683.5*

Electronic Installation Amt. (Line A-4-C) . . . . + *24.3*

(Sum = adjustable cost component) . *707.8* = - *707.8*

(Difference from Step 1 result; carry to Step 4) *67.0*

STEP 3: REDUCE ADJUSTABLE COSTS (Use Table 1 of FAA-ASP-76-7):

(Enter proxy location used if actual site not listed in Table 1, e.g., Naknek for Dillingham:

__________________________________)

(Adj. cost component) *707.8* ÷
(Adj. factor, from table) *2.39* = *296.2* +

STEP 4: SUM = ADJUSTED REGIONAL COST. *363.2*

Incorporation in B/C Methodology
(from Report ASP-75-4)

		(Actual Amount)
Add Washington Office cost	+ *98.0*	
Remoteness-adjusted project cost	*461.2*	(*872.8*)
Annualized and discounted per ASP-75-4	x 0.13147	
Remoteness-adjusted annual capital recovery cost . . .	*60.6*	(*114.7*)
Plus operating cost per ASP-75-4: Staffing..............$119,532 Stocks and stores...... 1,750 Maintenance........... 21,905 $143,187	+ 143.2	
Remoteness-adjusted annual tower cost.	*203.8*	(*257.9*)
Benefit value at *CY 75* activity level (see text). .	*233.5*	
Remote-cost adjusted B/C ratio (*233.5* ÷ *203.8*). . . .	*1.15*	(*0.91*)

The effect of establishment cost adjustment methodology on B/C analysis is further diluted by the introduction of operating and maintenance (O&M) costs, which may equal or exceed capital recovery cost. Still, the cost adjustment technique is potent enough to improve substantially the B/C ratios for remote facilities, as Table 2 shows.

At first glance, it appears that the methodology works satisfactorily when applied to tower proposals but fails altogether when applied to VASI's. Closer inspection, however, indicates that the effect is similar for each facility type and that, in percentage terms, the VASI B/C ratios actually got more of a boost (roughly 50 percent average) than did the ATCT ratios. (B/C ratios were rounded to avoid distorting the impact of the methodology on the small values generated by the VASI proposals.)

The VASI proposals, as evaluated by draft B/C criteria, were not redeemed by this methodology because they simply were too benefit-poor to begin with. Nine of the eleven did not meet the existing VASI criteria, which essentially require 5,000 landings.

The methodology developed here should not and does not forgive every exceptional cost associated with providing remote facilities. The extra digging required to achieve electrical grounding in permafrost, for example, is not dismissed. The cost of this digging is just made comparable, along with other construction/installation costs, to the expense of doing the same digging at a corresponding location in the CONUS--even though it might never need to be done there.

Similarly, although the benefit enhancement technique developed in the following section may produce further improvement in B/C ratios, it does not alter the fundamental benefit determinants or manufacture benefits where there are none.

The rightmost column of Table 2 shows the sort of unadjusted B/C ratio that would have been needed, at the given benefit levels, to produce a cost-adjusted B/C ratio of 1.00 (assuming the same unadjustable cost component). As the table suggests, because of differences in cost mix and adjustment factors, there is no generalized threshold below which submission should not be attempted. However, it clearly becomes difficult to salvage proposals if the initial B/C ratios fall below 0.70, and impossible if benefits do not even cover Washington office cost plus O&M.

TABLE 2

Cost Adjustment Impact on Eligible Remote Facility Proposals
in the FY-78 Call for Estimates*

	Phase I Sum of Ratio Values	Actual Regional Cost	Actual B/C Ratio+	Remoteness - Adjusted Regional Cost	Remoteness - Adjusted B/C Ratio+	(Index Proxies Used)	Percent Improvement in B/C Ratio	Minimum Initial Ratio to Qualify
Towers								
Bethel	1.32	774,800	0.91	361,466	1.15		26%	0.70
Dillingham	1.24	743,900	0.90	394,154	1.10	(Naknek)	22%	0.77
VASIs (Rwys)								
Big Delta (18)	0.60	83,600	0.12	41,716	0.18		43%	#
Birchwood (19)	1.40	64,100	0.37	36,806	0.47	(Elmendorf)	30%	#
Dutch Harbor (13)	0.05	201,400	0.01	89,740	0.02		77%	#
Dutch Harbor (31)	0.13	83,200	0.04	40,102	0.05		43%	#
Iliamna (17)	0.18	70,100	0.04	37,641	0.06	(Naknek)	36%	#
Iliamna (35)	0.42	73,800	0.10	38,226	0.13	(Naknek)	38%	#
Sand Point (15)	0.04	68,200	0.02	31,107	0.03	(Cold Bay)	39%	#
Sand Point (33)	0.09	129,300	0.03	55,162	0.05	(Cold Bay)	64%	#
Umiat (05)	0.25	141,000	0.04	55,834	0.07	(Barrow)	76%	#
Umiat (23)	0.60	116,500	0.10	46,794	0.15	(Barrow)	68%	#
Valdez (23)	0.44	62,400	0.13	33,084	0.17	(Yakataga)	37%	#

* Only the Alaskan submissions were discerned to have proposals that would qualify for remoteness compensation, although Asia-Pacific Region and Southern Region submissions also were examined.

\+ Based on Washington office cost of $13,800 for 2-box VASI and $1,500 for flight check, and $40,000 for present value of 15 years' O&M cost, per ASP-76-2.

\# Insufficient benefits to cover fixed costs.

IV. BENEFIT ENHANCEMENT

This methodology quantifies for the decisionmaker the extent to which terminal facilities at remote locations may be exceptionally beneficial--a factor heretofore represented solely by extra justification text accompanying facility proposals.

Benefits are enhanced on the basis of community reliance on aviation as measured by the paucity of alternative transportation, the level of communication with the outside world, and the level of aviation usage. These factors are combined to reflect the likelihood that a remote community resident will be using aviation in many cases when the counterpart elsewhere would normally use other modes.

There are many elements of information that would indicate this sort of aviation dependency: airlift of goods usually transported by surface modes, flight activity for purposes such as grocery shopping and school commuting, medical evacuations by air, etc. Most such uses, however, are not systematically measured and could be estimated only imprecisely.

The simplified aviation-dependency model shown here uses only a few proxy variables for which input data are readily available. The following input variables are explained more thoroughly in Appendix B.

Alternate mode availability. This is the most important respect in which remote areas differ from those in the CONUS and is the principal determinant of aviation dependency. It is an inverse proxy for the movement of goods and passengers by air rather than customary alternate modes.

Enplanements per population. This revealing datum has been shown to be much higher for Alaskan communities than those in the CONUS. Dependency varies directly as enplanements/population, which indicates the level of aviation usage and also is a proxy for air passenger travel on local errands which would use other modes in the CONUS.

Community size. An absolute measure of community size is needed to peg the benefit enhancement factor to the extent of need. Without such a measure, the maximum enhancement could conceivably be assigned to a single aviator-recluse

in an isolated camp. Therefore, dependency varies directly as population. (Mathematically, this population factor cancels with the "enplanements per population" denominator.)

Level of outside contact. To distinguish among communities similar in other respects but varying in the degree to which they rely on communication with the rest of the world, dependency is made to vary directly as adjusted postal revenues.

This, then, is the overall form of the model:

$$\text{Aviation dependence} = \frac{\text{Enplanements x Adjusted postal revenue}}{(\text{Alternate mode availability})^2}$$

The formula itself is shown in Appendix B.

Normalizing Assumptions

Alternate Modes

The foundation of this aviation dependency model is the assumption that "nonremote" towns typically are served by highway transport year-round but not by other surface modes. Alternate mode availability is the most critical element in the model, and the expression for alternate mode availability is constructed to equal 1 when road access is possible all year but no other surface transport is available. Additional surface transport options diminish the dependency raw score by the square of their availability times utility products, in effect dividing the enplanements and postal revenues by 185 when all three surface modes are continually available, as in Anchorage.

Communities having less than year-round road access are represented by fractional modal availability expressions which, squared, serve to multiply enplanements and revenues. McGrath, Alaska, with no mechanized surface transport link whatsoever, rates an effective multiplier of 200.

Postal Revenues

Net revenues recorded by the Postal Service have been adjusted to remove the approximate value of intracity mailings. (See Appendix A for the adjustment mechanism.) The

postal factor is then reduced by the model to a multiple of the smallest annual revenue figure found for a fourth-class post office.

Enplanements

The lowest enplanement figure found is used since the enhancement factor will, by definition, never be less than 1.

The data base from which enplanement figures were calculated (Appendix C) and upon which the model was calibrated consists of the 50-odd airports in the FAA's Terminal Area Forecast file which clearly meet the remoteness criteria set forth in the Introduction.

Raw Score

Raw scores range from near 1 to over 970,000; Appendix C shows these values along with the resulting benefit enhancement factors.

Raw scores are converted to enhancement factors by the following formula:

$$\text{Benefit enhancement factor} = 1+\left(\frac{\text{Raw value} - 1}{1{,}000{,}000}\right)$$

This produces enhancement factors from 1.00 to 1.97 and satisfies the requirement ("basic considerations") that this coefficient not be permitted to supersede primary criteria in the adjusted benefit result. The raw score conversion could, of course, be adjusted to serve future policy objectives, since remoteness compensation is a policy-induced mechanism in the first place.

Impact of Benefit Enhancement

The application of benefit enhancement factors to B/C ratios clearly will have little impact on the budget validation process. Not a single one of the Alaskan VASI proposals would be salvaged. The Bethel and Dillingham tower proposals, however, look better than ever:

	Phase I	B/C Ratios Actual	Cost-Adjusted	Benefit-Enhanced	Fully Adjusted
Bethel	1.32	0.91	1.15	1.79	2.27
Dillingham	1.24	0.90	1.10	1.45	1.77

But these proposals met Phase I criteria with room to spare. The benefit enhancement methodology indicates mathematically what the region wrote in prose by way of justification.

For all practical purposes, sites with factors less than 1.005 remain unadjusted. B/C ratios usually are calculated only to two decimal places; Appendix C is extravagantly precise for illustrative purposes only. All told, of the 54 sites significant enough to be included in the Terminal Area Forecast, 29 are not sufficiently aviation-reliant to obtain perceptible benefit enhancement. Only three (Bethel, Nome, and Dillingham) are enhanced by more than 50 percent.

Applying the Methodology

Benefit enhancement calculations are easily performed with a hand calculator using the step-by-step procedure in Appendix D.

The Planning Standards Branch, ASP-110, will calculate both cost and benefit adjustments on request. Proposals submitted in the annual Call for Estimates for which remoteness compensation is requested should contain the data listed in the following section.

The benefit enhancement factor is to be multiplied by the benefits calculated using establishment/discontinuance criteria B/C methodology. However, since benefits usually are calculated as an intermediate step in a complex computer program, the same result may be achieved by multiplying the benefit enhancement factor by the B/C ratio, of which benefits are the numerator.

V. CALL FOR ESTIMATES DATA REQUIREMENTS

The data elements listed below should be submitted by regions with the annual Call to enable remoteness-compensation methodology to be performed on proposals for which there are B/C-based criteria. For the FY-79 Call, these include ATCT, ASR, ILS, MLS+, VASI+, REILS+, ASDE, localizer/marker facilities+, and DME to be collocated with TVOR+. (+ denotes methodology still in preparation.)

Items preceded by an asterisk may be omitted if not readily available; ASP-110 will apply default values.

For cost adjustment:

1. FAA Form 2500-4 (9-76), with any housing construction itemized.

2. (If the proposed facility site is not listed in Table 1) Name of the town or area listed in Table 1 that best replicates the construction environment of the candidate site.

For benefit enhancement:

*1. Total enplanements in the most recent 12-month period.

2. (If enplanements not furnished) Total annual operations of air carriers, air taxis, itinerant general aviation.

3. Number of months site is accessible by water, highway, and rail each year--that is, months when mechanized water, highway, and rail transport link the site to a larger city or to an intermodal transfer point offering comparable service.

*4. Passenger utilization factors for water and rail modes (P_w, P_r) from the table on page B-4.

APPENDIX A

Development of the Composite Cost Index

To contrive a meaningful index of any variable requires collection of considerable empirical data. Fortunately, there are several indices that have been compiled by systematic accumulation of construction cost experience: one contained in the National Construction Estimator, one produced by the Department of Defense, and another compiled earlier by the U.S. Air Force. Figure A-1 shows a graphic comparison of these three indices.

The Estimator Index

This index, revised for each annual edition of The National Construction Estimator[1], has been cited in the FAA's Alaskan Region budget submissions. It is indexed to nationwide average costs rather than to the cost level in any one place. Although the Estimator treats commercial and industrial costs as well as residential, the geographic adjustment index reflects only residential cost factors. This index distinguishes three cost regions in Alaska (South Coast, Remote Interior, and Fairbanks) and three in Hawaii (Oahu, Kauai and Koloa, and Out Islands).

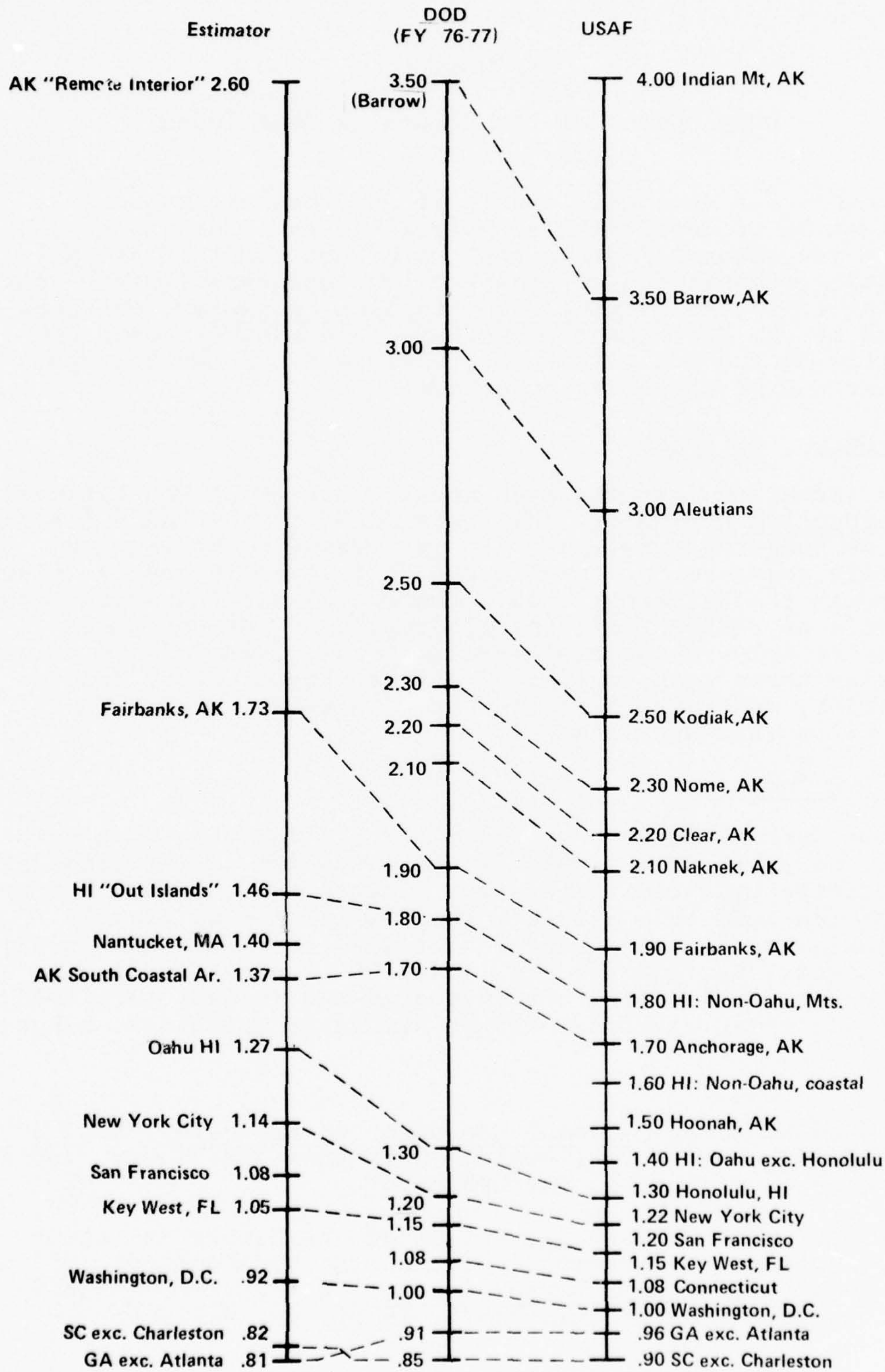
The DOD Index[2]

The Department of Defense has based its index on Washington, D.C., costs (D.C. = 1.00) for the permanent construction of repetitive-type facilities--not limited to residential construction. In this respect, the DOD index more closely approximates FAA construction activity than does the purely residential Estimator scale. The DOD index includes data processing facilities, air passenger and freight terminals, fire and crash stations, flight simulator buildings, hangars,

1. Gary Moselle, National Construction Estimator, 23rd ed. (Solana Beach, California: Craftsman, 1974), pp. 160-61. Hereafter cited as the Estimator.

2. Department of Defense, Office of the Deputy Assistant Secretary of Defense (Installations and Housing), Military Construction Cost Review Guide, DOD 4270.1-CG (Washington: Department of Defense, 1974, 1976), pp. 9-12.

Figure 5.--Comparison of construction cost indices



electronics shops, and so forth, in addition to chapels, commissaries, and quarters.

The DOD index is based on bid openings throughout the United States and is updated every two years. More detailed than the Estimator index in its Alaskan coverage, the FY 1976-1977 DOD scale listed eight distinct cost levels ranging from 1.70 times D.C. cost (Elmendorf AFB and Ft. Richardson) to 3.50 (Point Barrow). Two Hawaiian cost zones were distinguished: Oahu and Kauai.

The Air Force Index[3]

Similar to the DOD index, the USAF scale is less current (1970) but much more detailed, particularly with respect to higher-cost areas such as Alaska and Hawaii. It is indexed to Washington, D.C., and based on bid openings for permanent, repetitive-type construction, as is the DOD index. The USAF index, however, lists six Hawaiian cost zones and 85 Alaskan places. The USAF index also includes American Samoa, Guam, and other remote, insular locations.

The Composite Index

The index selected as a basis for adjusting FAA remote facility costs needed to be (1) based on construction similar to that performed by the FAA, (2) as detailed as possible to permit accurate application, and (3) current.

Both the DOD and USAF indices are superior to the Estimator index in the first two respects, and the DOD index is equally current, so the selection was narrowed to the two military indices. This appeared to present a choice between excellent detail in the relatively dated (1970) USAF index on the one hand and excellent currency in a significantly less detailed index (DOD) on the other.

Close comparison of the two military indices, however, indicated that all points outside the CONUS that are common to both have the same values in each. While relative construction costs have changed in the contiguous 48 states from 1970 to 1976, costs at external sites have, according to these indices, maintained the same relation to the Washington,

3. U.S. Air Force, Pricing Guide, AFP 88-16 (Washington: U.S. Air Force, 1970), pp. 3-8.

D.C., cost level. This perfect correlation between the military indices for points outside the CONUS permitted substitution of that more detailed portion of the USAF scale for the corresponding range on the DOD scale. The resulting composite cost index has the currency of the 1976-77 DOD index with the detailed Alaskan/Hawaiian breakdown of the USAF scale (plus values for island locations not included in the DOD index).

The DOD index for FY 1978-1979 was published after the composite index was developed. There were some relative shifts from the previous version, and therefore, Table 1 has been recalculated to bring the index up-to-date. However, not all graphs and illustrations were changed.

APPENDIX B

Details of Aviation Dependency Model

The following aviation dependency model, which produces the raw scores from which benefit enhancement factors are normalized, is shown here in generalized form:

$$\text{Raw score} = \frac{(A/N_a) \cdot (E/N_e)}{.005 + \left[\left(\frac{.5+Y^2}{1.5}\right) \cdot \left(\frac{P_wW_wM_w + P_hW_hM_h + P_rW_rM_r}{12}\right)\right]^2}$$

where:

A	=	Adjusted annual postal revenues
E	=	Total annual enplanements
N_a and N_e	=	Normalizers for A and E
Y	=	The number of surface modes available all year long
P	=	Passenger utilization factor
W	=	Modal utility weighting factor
M	=	Number of months of the year mode is available
w, h, r	=	Subscripts denoting water, highway, and rail modes

The treatment of these factors follows, in the order of their appearance in the formula.

Adjusted Postal Revenue (A)

The idea of using postal activity as an indicator of aviation dependency was incorporated in a model constructed by the Alaskan Department of Public Works, Aviation Division, in 1971. Post office class served that model adequately, since only very small communities were treated.

Post office class proved too coarse an interval against which to measure postal activity in communities of widely differing size. Post office class is a function of postal revenue, which the Postal Service records in machine-readable format. FY-75 data are used here.

Although postal revenue provides the finer gradation desired, it is severely skewed toward larger population centers, where local mailings, including advertising matter, swell the revenue tally. Therefore, to retain the integrity of the postal factor as an indicator of intercity contact, the following empirically-derived adjustment was made to first-class post office revenues (values in millions of dollars):

$$\text{Adjusted revenue} = \frac{1.25\ (\text{Actual revenue})}{(\text{Actual revenue} + 1.4)^{2/3}}$$

Remote area postal data includes fourth-class post offices with as little as \$400 annual revenue, so normalizing divisor N_a was set at 400.

Communities for which revenue was not recorded, such as "rural branches," were assigned a \$100 postal revenue figure.

It is intended that, as with other formula-based methodologies, the most up-to-date values be used whenever a facility proposal is examined. Postal revenues must be made an exception, however, because rapid postal rate increases would distort the apparent aviation dependency of a community for which later than FY-75 data were used.

Enplanements (E)

The cancellation of population with enplanements-per-population considerably simplifies use of the dependency model; enplanements are a mainstay of the aviation data environment. Where enplanements are not recorded, they are satisfactorily estimated by multiplying departures (half the operations) for each class of traffic (air carrier, air taxi, general aviation) by the average number of passengers per trip for that class.

Enplanements, not divided by population, becomes the only airport-specific variable in the model; the others all are related to the total community. This enables distinction

between benefit enhancement factors justified by different airports serving the same city (e.g., Anchorage International, Merrill, and Lake Hood Seaplane Base).

For this report, FY-75 departures were multipled by NAS-average air taxi (6.6) and general aviation (2.5) passengers-per-trip. (These values are used in facility establishment criteria as well.)

Air carrier departures were multiplied by average enplanements-per-trip calculated from FY-74 (latest available) Civil Aeronautics Board (CAB) statistics for each major area:

Area	Average AC Passengers
Alaska	13
Pacific	59
Puerto Rico	98

Some sites will inevitably be shortchanged by this approximation; recorded figures are preferred and should, if possible, be submitted with any request for proposal-related site evaluation. Airports served by only one or two air carriers, each able to supply current actual data, might be helped that way. Year-older CAB figures also are acceptable.

N_e assumes a value of 4,550--the lowest annual enplanement total encountered in the set of locations used here.

Year-Round Alternate Modes (Y)

This indicates the full-year availability of water and/or highway and/or rail access to the community modeled. In terms of the other variables, it is the number of modes for which M = 12.

Months ($M_{w,h,r}$) of Access

Severe climatic changes make some Alaskan points accessible in summer but inaccessible in winter, when ports may be ice-bound or roads impassable. M represents the average number of months the subscripted mode is available each year. Here, "available" means capable of providing access either to a

larger city or another intermodal transfer point where comparable service is available.

Modal Utility Weights ($W_{w,h,r}$)

Since modes differ as to speed, flexibility, and safety, an allowance is made for the relatively lower utility of rail and water transport compared with highway access. Relative utilities were found in the Alaskan Government's aviation-dependency model, which used results of a poll of transportation executives in the state. These relative measures are here normalized to $W_h = 1.00$, so that W_w becomes 0.51 and $W_r = 0.64$.

Passenger Usage Adjustment ($P_{w,h,r}$)

All surface modes are assumed to enable cargo movement, but passenger service is not always offered. Passenger utilization coefficients are:

Passenger Utilization	P_i
Continually used by passengers	1.00
Frequently used by passengers	.90
Occasionally used by passengers	.75
Rarely used by passengers	.65
Never used by passengers	.50

Factors for highway (P_h) and rail (P_r) are assumed to be constant (1.00) for all the sites considered here.

The Model with Constants

This is the streamlined version of the aviation-dependency model:

$$\text{Raw Score} = \frac{(A/400) \cdot (E/4550)}{.005 + \left[\left(\frac{.5+Y^2}{1.5}\right) \cdot \left(\frac{.51P_wM_w + M_h + .64M_r}{12}\right)\right]^2}$$

or, using the predigested input data ("PREFAB" values from Appendix E):

$$\text{Raw Score} = \frac{(\text{Enplanements}) \cdot (\text{"PREFAB"})}{.005 + \left[\left(\frac{.5 + Y^2}{1.5}\right) \cdot \left(\frac{.51 P_w M_w + M_h + .64 M_r}{12}\right)\right]^2}$$

APPENDIX C

Remote Site Benefit Enhancement Factors

Site Nr.	Airport	Benefit Enhancement Factor	Raw Value
Alaska			
50034.0	Anchorage Intl	1.0032	3245.9
50035.0	Merrill	1.0014	1357.4
50037.0	Lk Hood	1.0005	469.8
50037.40	St Mary's	1.0238	23803.8
50038.0	Aniak	1.0351	35114.5
50054.30	Wiley-Post	1.1005	100541.8
50061.10	Bethel	1.9701	970056.3
50062.0	Bettles	1.0171	17060.8
50069.0	Birchwood	1.0000	7.2
50114.0	Cold Bay	1.0016	1580.9
50124.0	Cordova-Mile 13 Fld	1.0033	3283.8
50140.70	Deadhorse	1.0003	292.0
50153.0	Dillingham	1.6091	609129.6
50219.0	Fairbanks-Intl	1.0086	8627.9
50235.0	Ft Yukon	1.0451	45063.8
50258.0	Galena	1.0235	23537.3
50281.0	Gulkana	1.0000	1.1
50320.0	Homer	1.0001	101.4
50385.0	Juneau	1.0022	2195.3

Site Nr.	Airport	Benefit Enhancement Factor	Raw Value
50410.0	Kenai-Muni	1.0004	390.1
50412.03	Ketchikan	1.0298	29832.9
50416.0	King Salmon	1.0075	7547.3
50425.0	Kodiak	1.0106	10585.7
50429.0	Ralph Wein Memorial	1.3340	333995.4
50467.0	McGrath	1.0459	45902.8
50540.0	Nome	1.7710	770958.2
50584.0	Palmer Muni	1.0001	71.1
50590.20	Petersburg	1.0040	3970.0
50696.0	Seward	1.0000	1.8
50703.0	Sitka	1.0099	9862.3
50704.0	Skagway	1.0000	17.3
50795.0	Umiat	1.0000	50.0
50799.0	Unalakleet	1.0355	35504.7
50825.10	Valdez Muni	1.0000	37.0
50905.20	Wrangell	1.0044	4407.0
50920.0	Yakutat	1.0028	2758.7
Pacific			
51510.0	Agana	1.0945	94499.0
51512.0	Babelthua	1.0000	1.6
51516.20	Bucholz Army	1.0000	9.9
51518.01	Marshall Islands Intl	1.0000	2.7

Site Nr.	Airport	Benefit Enhancement Factor	Raw Value
51525.0	Pago Pago Intl	1.0138	13777.7
51530.0	Ponape	1.0000	2.9
51531.0	Rota Intl	1.0000	2.2
51532.0	Kobler Intl	1.0000	11.5
51550.0	Yap	1.0000	2.1
52061.0	Hana	1.0000	21.1
52095.0	General Lyman Fld	1.0156	15639.6
52240.0	Kahului	1.0124	12447.5
52250.20	Ke-Ahole	1.0032	3158.3
52276.0	Kamuela	1.0047	4702.4
52294.0	Kaunakakai	1.0207	20699.5
52420.0	Lihue Airport	1.0081	8054.2
Puerto Rico			
53180.0	Isle Grande	1.0133	13299.9
53180.10	Puerto Rico Intl	1.2559	255938.0

APPENDIX D

Procedure for Calculating Benefit Enhancement Factors

(To simplify calculations, adjusted postal revenues, its normalizing constant, and the normalizer for enplanements have been combined already for most sites and the results are shown in Appendix E.)

Step 1

Be sure the site meets the remoteness standards set forth in the Introduction.

Assemble the data called for in Part V, page 27.

Step 2

(If enplanements are already available, skip to Step 6.)

Multiply annual air carrier (AC) operations by 6.5 for Alaskan sites, by 20 for CONUS sites, by 29.5 for Pacific sites, or by 49 for San Juan to find AC enplanements.

Step 3

Multiply annual air taxi (AT) operations by 3.3 to find AT enplanements.

Step 4

Multiply annual itinerant general aviation (GA) operations by 1.25 to find GA enplanements.

Step 5

Add the results of Steps 2-4 to obtain total annual enplanements.

Step 6

Multiply enplanements by the "PREFAB" value listed for the candidate site in Appendix E to obtain the depencency numerator.

(If the site is not listed, use a "PREFAB" value of .00022.)

Step 7

Multiply the months water transport is available (M_w) by the appropriate boat passenger utilization factor (P_w, from the table on page B-4) by 0.51 to obtain the water product.

Step 8

Multiply the months rail transport is available (M_r) by the appropriate rail passenger utilization factor (P_r, as in Step 7) by 0.64 to find the rail product.

Step 9

Add the months highway travel is available (M_h) to the rail product (Step 8) and the water product (Step 7) and divide the sum by 12 to arrive at the weighted mode-years. (It will be between zero and 2.15.)

Step 10

Count the number of surface modes (Steps 7, 8, and 9) available 12 months per year and select the corresponding coefficient below:

All-Year Modes	Coefficient
0	0.33
1	1.00
2	3.00
3	6.33

Step 11

Multiply the coefficient from Step 10 by the weighted mode-years from Step 9, then square the result. This is the alternate mode availability; it will range from 0 to 185.22.

Step 12

Add .005 to the alternate mode availability from Step 11. This is the denominator.

Step 13

Divide the numerator (Step 6) by the denominator (Step 12) to achieve the aviation dependency raw score. Scores commonly range from 1 into the hundreds of thousands. A score of 1 million or more suggests a likelihood of computational error.

Step 14

Subtract 1 from the raw score (last step), divide by 1,000,000, then add 1.

This is the benefit enhancement factor which, multiplied by the B/C ratio for a facility proposal, yields the benefit-adjusted B/C ratio. Multiplied by the cost-adjusted B/C ratio, it produces a fully-compensated B/C ratio.

APPENDIX E

Adjusted Postal Revenues and
"PREFAB" Computational Aid*

Post Office	Zip	Adj. Revenue	"PREFAB"
Alaska			
Akiachak	99551	1788.	0.00098
Akiak	99552	857.	0.00047
Akutan	99553	1328.	0.00073
Alakanuk	99554	5935.	0.00326
Aleknagik	99555	2979.	0.00164
Allakaket	99720	2128.	0.00117
Ambler	99786	3566.	0.00196
Anaktuvuk Pass	99721	3050.	0.00168
Anchorage	99502	2315793.	1.27241
Anchor Point	99556	10781.	0.00592
Angoon	99820	5181.	0.00285
Aniak	99557	11383.	0.00625
Annette	99920	12523.	0.00688
Anvik	99558	2011.	0.00110
Arctic Village	99722	2389.	0.00131
Auke Bay	99821	33350.	0.01832
Barrow	99723	54814.	0.03012
Beaver	99724	1388.	0.00076
Bethel	99559	114591.	0.06296
Bettles Field	99726	5308.	0.00292
Brevig Mission	99785	790.	0.00043
Buckland	99727	1817.	0.00100
Cantwell	99729	3536.	0.00194
Central	99730	2452.	0.00135
Chatanika	99731	409.	0.00022
Chefornak	99561	4021.	0.00221
Chevak	99563	3612.	0.00198
Chicken	99732	1215.	0.00067
Chignik	99564	3602.	0.00198
Chignik Lagoon	99565	1899.	0.00104

* Includes some towns without airports and ineligible sites on Oahu.

Post Office	Zip	Adj. Revenue	"PREFAB"
Chitina	99566	2577.	0.00142
Chugiak	99567	33404.	0.01835
Circle	99733	1492.	0.00082
Clam Gulch	99568	2912.	0.00160
Clarks Point	99569	1792.	0.00098
Cohoe	99570	2634.	0.00145
Cold Bay	99571	10225.	0.00562
Cooper Landing	99572	5998.	0.00330
Copper Center	99573	19264.	0.01058
Cordova	99574	97195.	0.05340
Craig	99921	17589.	0.00966
Crooked Creek	99575	818.	0.00045
Deering	99736	1854.	0.00102
Delta Junction	99737	58795.	0.03230
Dillingham	99576	55543.	0.03052
Eagle	99738	3960.	0.00218
Eagle River	99577	112447.	0.06178
Eek	99578	2033.	0.00112
Egegik	99579	2949.	0.00162
Ekwok	99580	2301.	0.00126
Elfin Cove	99825	1962.	0.00108
Elim	99739	1937.	0.00106
Emmonak	99581	8057.	0.00443
Ester	99725	2531.	0.00139
Fairbanks	99701	1308394.	0.71890
False Pass	99583	3449.	0.00190
Flat	99584	500.	0.00027
Fortuna Ledge	99585	2311.	0.00127
Fort Yukon	99740	19562.	0.01075
Gakona	99586	5640.	0.00310
Galena	99741	15556.	0.00855
Gambell	99742	6157.	0.00338
Girdwood	99587	11962.	0.00657
Glenallen	99588	51966.	0.02855
Goodnews Bay	99589	1703.	0.00094
Grayling	99590	2239.	0.00123
Gustavus	99826	4737.	0.00260
Haines	99827	70218.	0.03858
Healy	99743	12179.	0.00669
Holy Cross	99602	3916.	0.00215

Post Office	Zip	Adj. Revenue	"PREFAB"
Homer	99603	114639.	0.06299
Hoonah	99829	16717.	0.00919
Hooper Bay	99604	7033.	0.00386
Hope	99605	2068.	0.00114
Hughes	99745	1009.	0.00055
Huslia	99746	2766.	0.00152
Hydaburg	99922	7026.	0.00386
Hyder	99923	1673.	0.00092
Iliamna	99606	8679.	0.00477
Juneau	99801	826571.	0.45416
Kake	99830	12181.	0.00669
Kaktovik	99747	9033.	0.00496
Kalskag	99607	1085.	0.00060
Kaltag	99748	2386.	0.00131
Karluk	99608	1461.	0.00080
Kasigluk	99609	1910.	0.00105
Kasilof	99610	4467.	0.00245
Kenai	99611	211276.	0.11609
Ketchikan	99901	422851.	0.23234
Kiana	99749	4843.	0.00266
King Cove	99612	11788.	0.00648
King Salmon	99613	19480.	0.01070
Kipnuk	99614	7681.	0.00422
Kivalina	99750	3191.	0.00175
Klawock	99925	7148.	0.00393
Kobuk	99751	3048.	0.00167
Kodiak	99615	277051.	0.15223
Kotlik	99620	2604.	0.00143
Kotzebue	99752	58619.	0.03221
Koyuk	99753	1770.	0.00097
Koyukuk	99754	1221.	0.00067
Kwethluk	99621	2244.	0.00123
Kwigillingok	99622	1944.	0.00107
Lake Minchumina	99623	528.	0.00029
Larsen Bay	99624	2384.	0.00131
Levelock	99625	1678.	0.00092
Lower Kalskag	99626	1734.	0.00095
Mc Grath	99627	10865.	0.00597
Manley Hot Springs	99756	2605.	0.00143
Manokotak	99628	2473.	0.00136

Post Office	Zip	Adj. Revenue	"PREFAB"
Medfra	99629	412.	0.00023
Mekoryuk	99630	4435.	0.00244
Metlakatla	99926	26606.	0.01462
Minto	99758	934.	0.00051
Moose Pass	99631	4687.	0.00258
Mountain Village	99632	11691.	0.00642
Naknek	99633	14202.	0.00780
Napakiak	99634	1971.	0.00108
Nenana	99760	15021.	0.00825
New Stuyahok	99636	2031.	0.00112
Nikolski	99638	1837.	0.00101
Ninilchik	99639	9353.	0.00514
Noatak	99761	2853.	0.00157
Nome	99762	117763.	0.06470
Nondalton	99640	1211.	0.00067
Noorvik	99763	5626.	0.00309
Northway	99764	4117.	0.00226
Nulato	99765	4496.	0.00247
Nunapitchuk	99641	2489.	0.00137
Old Harbor	99643	5460.	0.00300
Ouzinkie	99644	3679.	0.00202
Palmer	99645	194051.	0.10662
Pelican	99832	10035.	0.00551
Perryville	99648	1840.	0.00101
Petersburg	99833	112204.	0.06165
Pilot Point	99649	9726.	0.00534
Pilot Station	99650	2511.	0.00138
Platinum	99651	3322.	0.00183
Point Baker	99927	1487.	0.00082
Point Hope	99766	6002.	0.00330
Port Alsworth	99653	1715.	0.00094
Port Lions	99550	5747.	0.00316
Quinhagak	99655	2962.	0.00163
Red Devil	99656	777.	0.00043
Ruby	99768	2516.	0.00138
Russian Mission	99657	982.	0.00054
Saint Marys	99658	10580.	0.00581
Saint Michael	99659	3407.	0.00187
Saint Paul Island	99660	12862.	0.00707
Sand Point	99661	15664.	0.00861

Post Office	Zip	Adj. Revenue	"PREFAB"
Savoonga	99769	5380.	0.00296
Scammon Bay	99662	2840.	0.00156
Selawik	99770	6347.	0.00349
Seldovia	99663	15445.	0.00849
Seward	99664	84893.	0.04664
Shageluk	99665	1638.	0.00090
Shaktoolik	99771	1950.	0.00107
Shishmaref	99772	4193.	0.00230
Shungnak	99773	2122.	0.00117
Sitka	99835	240601.	0.13220
Skagway	99840	43878.	0.02411
Skwentna	99667	696.	0.00038
Sleetmute	99668	878.	0.00048
Soldotna	99669	127489.	0.07005
South Naknek	99670	3423.	0.00188
Stebbins	99671	2676.	0.00147
Sterling	99672	6632.	0.00364
Stevens Village	99774	912.	0.00050
Sutton	99674	3393.	0.00186
Talkeetna	99676	11768.	0.00647
Tanana	99777	12860.	0.00707
Tatitlek	99677	394.	0.00022
Teller	99778	2225.	0.00122
Tenakee Springs	99841	5182.	0.00285
Togiak	99678	8008.	0.00440
Tok	99780	29440.	0.01618
Tununak	99681	4600.	0.00253
Tyonek	99682	3024.	0.00166
Unalakleet	99684	16054.	0.00882
Unalaska	99685	20491.	0.01126
Valdez	99686	105472.	0.05795
Venetie	99781	1852.	0.00102
Wainwright	99782	5201.	0.00286
Wales	99783	2357.	0.00130
Ward Cove	99928	20400.	0.01121
Wasilla	99687	47993.	0.02637
White Mountain	99784	1308.	0.00072
Willow	99688	10500.	0.00577
Wrangell	99929	93715.	0.05149
Yakutat	99689	19168.	0.01053

Post Office	Zip	Adj. Revenue	"PREFAB"
Guam			
Agana	96910	1276107.	0.70116
Hawaii			
Aiea	96701	397407.	0.21836
Anahola	96703	12536.	0.00689
Captain Cook	96704	54345.	0.02986
Eleele	96705	62009.	0.03407
Ewa Beach	96706	320934.	0.17634
Haiku	96708	20362.	0.01119
Hakalau	96710	12575.	0.00691
Haleiwa	96712	103396.	0.05681
Hana	96713	35366.	0.01943
Hanalei	96714	32424.	0.01782
Hanapepe	96716	45938.	0.02524
Hauula	96717	29525.	0.01622
Hawaii Nat Pk	96718	13080.	0.00719
Hawi	96719	26669.	0.01465
Hilo	96720	904138.	0.49678
Holualoa	96725	20569.	0.01130
Honaunau	96726	13336.	0.00733
Honokaa	96727	77732.	0.04271
Honomu	96728	10141.	0.00557
Hoolehua	96729	6542.	0.00359
Kaaawa	96730	18170.	0.00998
Kahuku	96731	53822.	0.02957
Kahului	96732	419162.	0.23031
Kailua	96734	569641.	0.31299
Kailua Kona	96740	263281.	0.14466
Kalaheo	96741	25660.	0.01410
Kalaupapa	96742	6923.	0.00380
Kamuela	96743	137347.	0.07547
Kaneohe	96744	415226.	0.22815
Kapaa	96746	137675.	0.07565
Kapaau	96755	34195.	0.01879
Kaumakani	96747	13177.	0.00724
Kaunakakai	96748	69871.	0.03839
Keaau	96749	72749.	0.03997
Kealakekua	96750	112619.	0.06188

Post Office	Zip	Adj. Revenue	"PREFAB"
Kealia	96751	10271.	0.00564
Kekaha	96752	33809.	0.01858
Kihei	96753	86097.	0.04731
Kilauea	96754	13004.	0.00714
Koloa	96756	67806.	0.03726
Kualapuu	96757	12791.	0.00703
Kula	96790	30965.	0.01701
Kunia	96759	10422.	0.00573
Kurtistown	96760	21146.	0.01162
Lahaina	96761	380986.	0.20933
Laie	96762	91884.	0.05049
Lanai City	96763	41452.	0.02278
Laupahoehoe	96764	7911.	0.00435
Lawai	96765	29055.	0.01596
Lihue	96766	393017.	0.21594
Makawao	96768	79496.	0.04368
Makaweli	96769	9444.	0.00519
Maunaloa	96770	7778.	0.00427
Mountainview	96771	46551.	0.02558
Naalehu	96772	29815.	0.01638
Ninole	96773	6782.	0.00373
Ookala	96774	5997.	0.00330
Paauhau	96775	6638.	0.00365
Paauilo	96776	14880.	0.00818
Pahala	96777	31246.	0.01717
Pahoa	96778	59171.	0.03251
Paia	96779	58577.	0.03219
Papaaloa	96780	10423.	0.00573
Papaikou	96781	38357.	0.02108
Pearl City	96782	315358.	0.17327
Pepeekeo	96783	35172.	0.01933
Puunene	96784	47937.	0.02634
Volcano	96785	15048.	0.00827
Wahiawa	96786	649856.	0.35706
Waialua	96791	79084.	0.04345
Waianae	96792	220673.	0.12125
Wailuku	96793	350119.	0.19237
Waimanalo	96795	57466.	0.03157
Waimea	96796	62353.	0.03426
Waipahu	96797	319011.	0.17528
American Samoa			
Pago Pago	96799	276898.	0.15214

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